Comment

Comment on 'Note on the dog-and-rabbit chase problem in introductory kinematics'

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Abstract. We comment on the recent paper by Yuan Qing-Xin and Du Yin-Xiao (2008 *Eur. J. Phys.* **29** N43–N45).

In a recent interesting letter [1] Yuan Qing-Xin and Du Yin-Xiao presented a new simple derivation of the critical region for the dog-and-rabbit chase problem. We would like to indicate that the equation (6) of [1], on which their treatment is based, can be obtained in a very simple and transparent way.

Let radius-vectors of the rabbit and the dog are $\vec{r}_1$ and $\vec{r}_2$, respectively, and the corresponding velocities $\vec{V}_1$ and $\vec{V}_2$. Relative radius-vector $\vec{r} = \vec{r}_1 - \vec{r}_2$ is parallel to the dog's velocity $\vec{V}_2$ because the dog is always heading towards the rabbit. Hence it is perpendicular to the dog's acceleration $\dot{\vec{V}}_2$ as the dog runs with the constant in magnitude velocity and therefore $\vec{V}_2 \cdot \dot{\vec{V}}_2 = 0$. Using this fact and taking into account that $\dot{\vec{V}}_1 = 0$, we get easily

$$\frac{d}{dt}\left[\vec{r}\cdot(\vec{V}_1+\vec{V}_2)\right] = (\vec{V}_1-\vec{V}_2)\cdot(\vec{V}_1+\vec{V}_2) = V_1^2 - V_2^2. \tag{1}$$

But r.h.s of this equation is a constant and if we integrate both sides of it with respect to time from $t=0$ to $t=T$, when the dog catches the rabbit, and solve with respect to the duration T of the chase, we get

$$T = \frac{\left[\vec{r}\cdot(\vec{V}_1+\vec{V}_2)\right]\Big|_{t=0}}{V_2^2 - V_1^2}. \tag{2}$$

A simple glance on the figure 1 from [1] is sufficient to deduce that at the beginning of the chase

$$\left[\vec{r}\cdot(\vec{V}_1+\vec{V}_2)\right]\Big|_{t=0} = L\left(V_1\sin\alpha + V_2\right).$$

Therefore, for the distance $s = V_1 T$, run by the rabbit before being caught by the dog, we get

$$s = L\frac{V_1\left(V_1\sin\alpha+V_2\right)}{V_2^2-V_1^2} = L\frac{e\left(e\sin\alpha+1\right)}{1-e^2}, \tag{3}$$

with $e = V_1/V_2$. This is just the equation (6) from [1].

References

[1] Qing-Xin Y and Yin-Xiao D 2008 Note on the dog-and-rabbit chase problem in introductory kinematics *Eur. J. Phys.* **29** N43–N45